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Do Agricultural Subsidies Crowd-out or Stimulate Rural Credit Market Institutions: The case of CAP Payments¹

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Abstract

In this paper we estimate the impact of CAP subsidies on farm bank loans. According to the theoretical results, if subsidies are paid at the beginning of the growing season they may reduce bank loans, whereas if they are paid at the end of the season they increase bank loans, but these results are conditional on credit constraint and on the relative cost of internal and external financing. In empirical analysis we use the FADN farm level panel data for period 1995-2007. We employ the fixed effects and the GMM models to estimate the impact of subsidies on farm loans. The estimated results suggest that (i) subsidies influence farm loans and the effects tend to be non-linear and indirect; (ii) both coupled and decoupled subsidies stimulate long-term farm loans, but the long-term loans of big farms increase more than those of small farms due to decoupled subsidies; (iii) the short-term loans are affected only by decoupled subsidies, and they are altered by decoupled subsidies more for small farms than for large farms; however (v) when controlling for the endogeneity, only the decoupled payments appear to affect loans and the relationship is non-linear.

Introduction

Agricultural subsidies have important impacts on agricultural markets. Besides affecting farmers' income, studies have shown that agricultural subsidies distort input and output markets and thus alter rents of other agents active in the agricultural sector (for example consumers or input suppliers). The impact of agricultural subsidies on income distributional effects depends on their type, structure of markets and the existence of market imperfections (Alston and James 2002; de Gorter and Meilke 1989; Gardner 1983; Guyomard, Mouël, and Gohin 2004; Salhofer 1996; Ciaian and Swinnen 2009). Studies also evaluate, among others, impacts of subsidies on the environment and agricultural public goods (e.g. Beers Van Cees and Van Den Bergh 2001; Khanna, Isik and Zilberman 2002) or productivity and market distortions (e.g. Chau and de Gorter 2005; Goodwin and Mishra 2006; Sckokai and Moro 2006).

With few exceptions (e.g. Ciaian and Swinnen 2009), most of these studies investigate the direct impacts of subsidies (on prices, quantities, income, environment, etc.) by assuming that subsidies do not alter the structure of agricultural markets and do not interact with market institutions. In reality government policies may have various unintended effects. They can change the structure of the market organization or crowd out some market institutions. An analysis of such effects goes beyond the focus of the current agricultural policy analysis literature.⁵

The objective of this paper is to assess the impact of the European Union's Common Agricultural Policy (CAP) on farm bank loans. First, extending the models of Feder (1985), Carter and Wiebe (1990) and Ciaian and Swinnen (2009) we theoretically analyze how subsidies may affect farm loans. Then, employing a unique farm level Farm Accountancy Data Network (FADN) panel data for the period 1995-2007 we empirically estimate the interaction between CAP subsidies and farm loans. To our knowledge, this paper is one of the first attempts to study empirically how agricultural subsidies affect rural credit institutions.

¹ The authors are grateful to Unit L.3 Microeconomic analysis of EU agricultural holdings from the European Commission for granting access to the FADN data. The authors acknowledge financial support from the European Commission FP7 project 'Rural Factor Markets'. The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

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⁵ These issues are related to "crowding out effects" of other types of government programs extensively analyzed in the literature. For example, the interaction between private transfers and public welfare programs attracted considerable attention from academic studies (e.g. Barro 1974; Lampman and Smeeding 1983; Roberts 1984; Maitra and Ray 2003; Cox, Hansen and Jimenez 2004).

The Model

We build a theoretical framework of the present study on the model of Feder (1985), Carter and Wiebe (1990), and Ciaian and Swinnen (2009). In this study we extend the three models by analyzing how subsidies affect farm demand for bank loans. We consider a representative profit-maximising farm. The farm output is a function of the fixed amount of land (A), fixed quantity of family labour (F)⁶ and non-land inputs (K), which we refer to as “fertilizer” but which captures also other capital inputs used by the farm. The production function is represented by a constant returns to scale production technology $f(A, K, F)$ with $f_i > 0$, $f_{ii} < 0$, $f_{ij} > 0$, for $i, j = A, K, F$. We assume that all land is owned by the farm. End-of-season profit is:

$$(1) \quad \Pi = pf(A, K, F) - k_c K$$

where $k_c = (1 + i_c)k$, p is the price of the final product, k is the per unit price of fertilizer and i_c is the interest rate. We assume that the economy is small and open, which implies that the fertilizer price, the interest rate, and the output price are fixed.

An important issue is the timing of various activities and payments. We assume that fertilizer is paid for at the beginning of the production season, whereas the revenue from the sale of production is collected after harvest at the end of the season. Because of the time lag between the payment for fertilizer (variable inputs) and obtaining revenues from sale of production the farm has a demand for the short-term credit. The demand for credit can be satisfied either internally (cash flow, savings, subsidy) or externally (bank loan, or trade credit). For the sake of simplicity we consider only external financing through the bank loan and later on in the paper also subsidy⁷. The demand for credit might not be fully satisfied, which means that the farm can be credit constrained.

Perfect Credit Markets

To establish a point of comparison, we first identify the equilibrium without credit constraint. With perfect credit markets, the farm is not constrained on the quantity of input it uses. The farm chooses the quantity of fertilizer that maximizes its profit given by equation (1). This implies the equilibrium condition:

$$(2) \quad pf_K = k_c$$

The condition (2) determines the farm’s fertilizer’s demand function. Total fertilizer demand is represented by function D_K in Figure 1. Because we assume that both fertilizer price and the interest rate are fixed, the supply of fertilizer is horizontal curve, S . The equilibrium quantity of fertilizer with no credit constraint is K^* .

Imperfect Credit Markets

It is assumed that the maximum amount of money that the farm can borrow from the bank (C) for fertilizer purchase depends on the farm collateral (W). For the sake of simplicity we consider that banks accept only assets as collateral.⁸ That is $C = C(W)$ where $dC/dW > 0$. The credit constraint is given by:

$$(3) \quad kK \leq C(W)$$

With the credit constraint the farm maximizes the end-season profit given by equation (1), subject to the credit constraint (3). This amounts to solving the LaGrangean function:

⁶ The assumption of fixed amount of land and family labour is not strictly needed to obtain the results. We introduce this assumption in order to simplify the exposition of the model results.

⁷ This assumption is not strictly needed to obtain the results.

⁸ This assumption is not strictly needed to obtain the results. In reality, the level of farm credit may depend on farm characteristics (e.g. reputation, owned assets, profitability). In general, the evidence from the literature shows that these factors are important determinants of farm credit (e.g. Benjamin and Phimister, 2002; Petrick and Latruffe, 2003; Latruffe, 2005; Briggeman, Towe and Morehart, 2009). For example, Latruffe (2005) finds in the case of Poland that farmers with more tangible assets and with more owned land were less credit constrained than others. Briggeman Towe and Morehart (2009) find for farm and non-farm sole proprietorships in US that the probability of being denied credit is reduced, among others, by net worth, income, price of assets, and subsidies.

$$(4) \quad \Psi = pf(A, K, F) - k_c K - \lambda_c (kK - C)$$

where λ_c is the shadow price of the credit constraint.

When the credit constraint is binding, $\lambda_c > 0$, the farm cannot use the unconstrained optimal level of fertilizer and the quantity demanded of fertilizer is determined by $K = C(W)/k$. The optimality conditions are:

$$(5) \quad pf_K - (1 + i_c + \lambda_c)k = 0$$

$$(6) \quad kK - C \leq 0.$$

From equation (5) it follows that the marginal value product of fertilizer is higher than the marginal cost of fertilizer k_c : $pf_K > k_c$. By increasing fertilizer use the farm could increase its profit but the credit constraint does not allow it to buy additional fertilizer.

In Figure 1 the credit constraint curve (i.e. fertilizer supply), represented in terms of fertilizer units, is given by the bold line $k_c A S_K$, where $S_K = C/k$. With the credit constraint, the equilibrium use of fertilizer is equal to K_c^* . Under credit constraint the farm uses less fertilizer than under the perfect competition, $K_c^* < K^*$.

Subsidies and Credit Constraint

We define DS as a decoupled subsidy which the farm receives irrespective of its level of production. With subsidy the objective function of the farm becomes:

$$(7) \quad \Pi = pf(A, K, F) - k_c K_c - k_s K_s + DS$$

where $k_s = (1 + i_s)k$, K_c is the fertilizer financed through the bank loan C , K_s is the fertilizer financed with subsidies DS , i_s represents farm's opportunity cost of subsidy (i.e. the return on the most profitable alternative investment opportunity), and $K = K_c + K_s$. We assume that the cost of bank loan is higher than the cost of subsidy, $i_c > i_s$. This assumption is reasonable given the information and incentive problems involved in providing a loan to the farm.

Subsidies affect not only the profit function but also the credit constraint. If the farm receives subsidy at the beginning of the season, it can use it for paying for the fertilizer. Receiving the subsidies at the end of the season improves the farm's access to credit too. Future guaranteed payment of subsidy may serve as collateral for obtaining loan from the bank (Ciaian and Swinnen 2009). Therefore subsidy may alleviate the credit constraint of the farm irrespective of the timing of the subsidy.

With subsidy credit constraint is given by the following inequalities:

$$(8) \quad kK \leq C[W + (1 - \alpha)DS] + \alpha DS$$

$$(9) \quad kK_s \leq \alpha DS$$

where α is a dummy variable taking value zero when farm uses subsidy to purchase fertilizer directly or one when subsidy improves access to fertilizer indirectly through enhanced value of collateral.

Equation (8) therefore implies that the farm can use two sources to finance the purchase of fertilizer: subsidy, αDS , and/or the bank loan, $C[W + (1 - \alpha)DS]$. If subsidy is paid at the beginning of the season, $\alpha = 1$, the farm can use it to alleviate its credit constraint. On the other hand when subsidy is paid at the end of the season, $\alpha = 0$, the farm may use it as collateral to obtain a bank loan. In other words, subsidy increases farm assets, improves its creditworthiness and thus increases access to bank loans. Equation (9) states that the use of subsidy for fertilizer purchase cannot exceed the total value of subsidies DS .

With subsidies and credit constraint the objective function of the farm is represented by the following LaGrangean function:

$$(10) \quad \Psi = pf(A, K, F) - k_c K_c - k_s K_s - \lambda_c \{kK - C[W + (1 - \alpha)DS] - \alpha DS\} - \lambda_s (kK_s - \alpha DS)$$

where λ_s is the shadow price of the subsidy constraint (9).

The optimality conditions are given by:

$$(11) \quad pf_K - (1 + i_c + \lambda_c)k = 0$$

$$(12) \quad pf_K - (1 + i_s + \lambda_s)k = 0$$

$$(13) \quad kK - C[W - (1 - \alpha)DS] - \alpha DS \leq 0$$

$$(14) \quad kK_s - \alpha DS \leq 0.$$

The Impact of Decoupled Subsidy

First, we consider the impact of decoupled subsidy on the bank loan under perfect credit market. Then we analyse the credit constraint case. We summarise our results in three hypotheses.

Hypothesis 1: *If farms are not credit constrained and if financing via bank loans is more expensive than financing through subsidies, subsidies reduce the amount of farms' bank loans if they are paid at the beginning of the season; otherwise subsidies do not affect the farm loans.*

If financing via the bank loan is more expensive than financing through the subsidy, $i_c > i_s$ (i.e. $k_c > k_s$), subsidy can reduce amount of bank loan but only in the case when the subsidy is paid at the beginning of the season. In such a case the farm can use the subsidy instead of the bank loan to buy fertilizer. The situation is illustrated graphically in Figure 1. With no credit constraint and with no subsidies, the equilibrium fertilizer use is K^* and all fertilizer is financed through the bank loan. Availability of cheaper financing through subsidy DS allows the farm to reduce the amount of bank loans. The farm will use less loan and part of the fertilizer will be financed with subsidy, equal to $K_s^* (= DS/k)$. The remaining fertilizer, $K^* - K_s^*$, will be bought with the bank loan. In welfare terms the farm gains area a in Figure 1. Note that with subsidy DS , the equilibrium fertilizer use is not affected and remains at K^* . Only if subsidies crowd out all bank loans, which occurs for sufficiently high subsidies (if $DS > kK^*$), the equilibrium fertilizer use increases.

If the subsidy is paid at the end of the season, the farm cannot use it directly to purchase fertilizer. However, subsidy can still be used as collateral. We assume that the type of collateral does not affect bank loan interest rate; hence the subsidy does not alter the equilibrium quantity of loans.⁹

Next we analyse the case when farm is credit constrained and subsidy is paid at the beginning of the season, $\alpha = 1$.

Hypothesis 2: *If farms are credit constrained and if subsidies are paid at the beginning of the season, (a) farms will use the same amount of loans with and without subsidies if subsidies are sufficiently small and (b) the farm will reduce bank loans if subsidies are sufficiently high.*

If the subsidy is paid at the beginning of the season the farm can use it directly to finance the purchase of fertilizer. The impact of subsidy on the bank loan under credit constraint is illustrated in Figure 2. The equilibrium quantity of fertilizer with the credit constraint and with no subsidy is K_c^* . First consider subsidy DS_1 . The subsidy DS_1 shifts the supply of fertilizer from $k_c DS_K$ to $k_s AES_{K1}$, where $S_{K1} = (C + DS_1)/k$. The equilibrium quantity of fertilizer is $K_{cs1}^* (= (C + DS_1)/k)$. Some fertilizer is financed directly from the subsidy, K_{s1}^* ($K_{s1}^* = DS_1/k$), and the rest is financed through the bank loan, K_c^* ($= K_{cs1}^* - K_{s1}^* = C/k$). The farm gains area ad when subsidy is used to purchase fertilizer under the credit constraint. Subsidy DS_1 does not change the quantity of the bank loan: with and without the subsidy the farm purchases the same amount of fertilizers through the bank loan, K_c^* . With subsidy DS_1 the farm is still credit constrained ($\lambda_c > 0$) – the amount of fertilizer K_{cs1}^* is lower than the amount of fertilizer used under

⁹ In reality, the type of collateral may affect the cost of the loan. For example, if banks perceive subsidies to be more secure and/or have lower transaction costs to administer them than other type of farm collateral, then the interest rate may be lower for subsidy backed loans than for the loans backed by the other type of collateral.

perfect market K^* , $K_{cs1}^* < K^*$ – and thus it is profitable for the farm to exploit fully all available financing opportunities (subsidies and loans).

However, if subsidy is sufficiently high, it can reduce the amount of bank loans. For example, with subsidy DS_2 , where $DS_2 > K^* - K_c^* > DS_1$, the supply of fertilizer shifts to $k_s B F S_{K2}$, where $S_{K2} = (C + DS_2)/k$ (Figure 2). The equilibrium fertilizer use changes to $K^* : K_{s2}^* (= DS_2/k)$ is financed from subsidy and $K^* - K_{s2}^*$ is financed with the bank loan. Now, the farm uses smaller amount of loans. The amount of fertilizer financed with the bank loan is $K^* - K_{s2}^*$, which is less than the total amount of fertilizer financed with bank loan without subsidy K_c^* . Intuitively subsidy DS_2 eliminates the credit constraint (i.e. the credit constraint (13) is not binding with DS_2 , $\lambda_c = 0$) and farm substitutes part of expensive bank loans with cheaper subsidies. With subsidy DS_2 the farm is not credit constrained and it uses the same level of fertilizer as under the perfect market situation, K^* .

Finally, we consider the situation with binding credit constraint when subsidy is paid at the end of the season, $\alpha = 0$.

Hypothesis 3: *If farms are credit constrained and if subsidies are paid at the end the season, the farm increases bank loans.*

The graphical analysis is in Figure 3. The fertilizer supply without the subsidy and with the credit constraint is $k_c A S_K$ and the equilibrium fertilizers use is K_c^* . If the credit constraint (8) is binding ($\lambda_c > 0$), it is profitable for the farm to use the subsidy DS paid at the end of the season ($\alpha = 0$) as collateral for obtaining a bank loan for purchase of fertilizer at the beginning of the season. Hence, because of higher collateral, subsidies increase bank loans from $C(W)$ to $C(W + DS)$, where $C(W) < C(W + DS)$. The availability of more loans shifts the fertilizer supply to $k_c B S_{K1}$ and the equilibrium fertilizer use to K_{c1}^* , where $K_{c1}^* > K_c^*$. Relative to the situation with no subsidy, the farm benefits from more loans; the gain is equal to area a . Note that for sufficiently high subsidy, the farm may become credit unconstrained (i.e. $\lambda_c = 0$). For example, this is the case when subsidy shifts the fertilizer supply to $k_c D S_{K2}$ which increases the equilibrium use to K^* and generates a gain for the farm equal to area ab .

Econometric specification

Theoretically the impact of decoupled subsidy on agricultural loans is ambiguous. Agricultural subsidies paid at the end of the season have no impact on bank loans under perfect markets while they reduce bank loans when paid at the beginning of the season. Under credit constraint subsidies paid at the beginning of the season have no impact on bank loans if they are sufficiently small but they reduce bank loans if they are sufficiently high. Furthermore, under credit constraint when subsidies are paid at the end of the season they reduce bank loans. The relationship between subsidies and bank loans is therefore an empirical question.

Solving the maximisation problem (equations (11)-(14)), the amount of farm loan depends on farm's subsidy, profitability, and assets. We therefore estimate the following econometric model:

$$(15) \quad loan_{jt} = \beta_0 + \beta_{ds} DS_{jt} + \beta_a assets + \beta_\pi \Pi_{jt} + \beta_x X_{jt} + \varepsilon_{jt}$$

where subscripts j and t represent farm and time, respectively; $loan$ stands for farm bank loans, $assets$ are farm assets and X_{jt} is a vector of observable covariates such as farm characteristics, regional, and time variables. As usual, ε_{jt} is the residual term.¹⁰

We are especially interested in estimating the parameter β_{ds} which measures the impact of subsidies on bank loans. Statistically significant negative value of the coefficient confirms either hypothesis 1 (subsidies paid at the beginning of the season reduce bank loans because farms are not credit constrained) or

¹⁰ The definition of the rest of the variables is the same as in the theoretical section.

hypothesis 2b (sufficiently high subsidies paid at the beginning of the season eliminate bank loans when farms are credit constrained). Statistically significant and positive coefficient confirms hypothesis 3 (farms are credit constrained and subsidies are paid at the end of the season). Finally, if the coefficient is not statistically significant, then the hypothesis 2a holds (farms with subsidies remain credit constrained and subsidies have no effect on farm loans).

We expect that data will confirm either hypothesis 2 or 3 because there is overwhelming evidence that farms are credit constrained (Carter 1988; Blancard et al. 2006; Lee and Chambers 1986; Fare, Grosskopf and Lee 1990). Further, anecdotal evidence indicates that subsidies tend to be paid at the end of the season¹¹ which implies that the hypothesis 3 should hold. This is in particular the case of the long-term loans which tend to finance investments with higher value than short-run loans.¹² Hence, the annual value of farms' subsidies may not cover the full costs of the long-term investments even if they are received at the beginning of the season. The hypothesis 3 is more likely to hold in the case of the long-term loans.

The estimation of equation (15) is subject to the omitted variable bias and particularly to the endogeneity. There are unobservable characteristics like farmer's ability that affect bank loans and may be correlated with explanatory variables. Ignoring this unobserved farm heterogeneity bias the results. We use panel data and estimate fixed effects model which helps us to control for the unobserved heterogeneity component that remains fixed over time thus reducing considerably the omitted variable bias problem. In order to control for the endogeneity we estimate the generalised method of moment (GMM) model.

Fixed effects model

The following fixed effects model estimation implies the following specification:

$$(16) \quad loan_{jt} = \beta_0 + b_j + \beta_{ds} DS_{jt} + \beta_a assets + \beta_\pi \Pi_{jt} + \beta_x X_{jt} + \varepsilon_{jt}$$

where b_j is the fixed effect for farm j , which capture time-unvarying farm-specific characteristics. These fixed effects represent farm heterogeneity. For example, they could reflect different technologies for different farms, or they could reflect different managerial skills or other unobservable fixed farm specific characteristics.

Endogeneity

Three sources of endogeneity might bias our estimates. If subsidies were assigned to farms randomly, then parameter β_{ds} would measure the impact of subsidies on bank loans. In reality, however, subsidies are not assigned randomly to farms. For example, the coupled animal and crop subsidies depend on regional and farm level productivities.

To address this source of endogeneity, we employ the Arellano and Bond (1991) robust two-step GMM estimator. Arellano and Bond (1991) have shown that lagged endogenous variables are valid instrument in panel data setting. This allows us to use lagged levels of the endogenous variables as instruments (additionally to exogenous variables), after the equation has been first-differenced to eliminate the farm specific effects. The GMM estimator is particularly suitable for datasets with a large number of cross-sections and few periods and it requires that there is no autocorrelation. The FADN dataset matches these requirements, because it is a panel data and contains a very large number of farm-level observations relative to the period covered. Given that the robust two-step GMM standard errors can be severely downward biased, we use the Windmeijer (2005) bias-corrected robust variances.

Data and variable construction

The main source of the data used in the empirical analysis is the Farm Accountancy Data Network (FADN), which is compiled and maintained by the European Commission. The FADN is a European system of sample surveys that take place each year and collect structural and accountancy data on the farms.

To our knowledge, the FADN is the only source of micro-economic data that is harmonised (the bookkeeping principles are the same across all EU Member States) and it is representative of the commercial

¹¹ There is not available consistent data on the timing of CAP subsidies.

¹² In perfect market situation, the price of an investment good is the present value of the future returns from the investment good which tends to be higher than the price of a variable inputs (e.g. fertilizers). The price of variable inputs is determined by its annual marginal contribution to the farm profitability.

agricultural holdings in the whole EU. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the EU. The survey does not, however, cover all the agricultural holdings in the Union, but only those which are of a size allowing them to rank as commercial holdings.

The FADN data is a panel dataset, which means that farms that stay in the panel in consecutive years can be traced over time using a unique identifier. In this study we use panel data for 1995-2007 covering all EU MS except Romania and Bulgaria. Romania and Bulgaria were excluded from the sample, because for these countries the data were available only for one year (2007).

All variables except for ratios are calculated per hectare of utilised agricultural area (UAA) in order to reduce the potential problem of heteroskedasticity. The dependent variables in equation (16) – *total loan*, *long-term loans*, *short-term loans* – are constructed from the FADN data by dividing total, long-medium-term and short-term loans, respectively, with the total utilised agricultural area.

Similarly, all subsidy variables (*sub_total_ha*, *sub_decoupled_ha*, *sub_coupled_ha*) are constructed from the FADN data and are calculated on per-hectare basis. Every agricultural producer in the FADN survey is asked to report both the total subsidies received as well as to specify the amount by major subsidy types. Decoupled subsidies, *sub_decoupled_ha*, include SPS and SAPS payments. Coupled subsidies, *sub_coupled_ha*, include payments linked to farm inputs or outputs such crop area payments, animal payments and RDP. The total subsidies, *sub_total_ha*, variable is the sum of coupled and decoupled CAP subsidies. The independent variables *assets* and *income_ha* represent the value of farm assets and farm cash flow calculated on per-hectare basis.

The covariates matrix X_{jt} includes other explanatory variables which affect farm loans. The following covariates were used: land rented ratio, labour own ratio, farm size, irrigated land, area under glass, fallow land, and sectoral, regional and time dummies.

Results

The results are reported in Table 1 for total farm loans (columns 1-3), for long-term farm loans (columns 4-6) and for short-term farm loans (columns 7-9).¹³ Additional to the complete equation specification (16), we add an interaction variable between subsidies and farm size (models 2, 3, 5, 6, 8 and 9) and the square value of subsidies (models 3, 6 and 9) to account for indirect and nonlinear relationship between subsidies and loans.

The model-adjusted R^2 s ranges from 0.10 to 0.49. The most consistently significant variables ($\text{prob}(t) < 0.10$) across all models are assets (*assets_ha*), trend variable (*year*), own labour ratio (*labor_own_ratio*), and rented land ratio (*land_rented_ratio*).

The estimated results suggest that subsidies influence farm loans but the effects are indirect and non-linear. The coefficient for subsidies in models 1, 4 and 7, where only a linear subsidy term is used, are statistically not significant for all types of loans. However, when interacting subsidies with farm size (models 2 and 5) its coefficient is statistically significant but only for total loans and for long-term loans. At the same time, the coefficient associated with the linear subsidy term *sub_total_ha* (the direct effect) is statistically significant and takes a negative value. This indicates that subsidies stimulate farm loans but only for larger farms, whereas the direct impact of subsidies has a reducing effect on total and long-term loans (models 2 and 5). For the short-term loans (model 8) both coefficients (i.e. for the interaction variable and the linear term *sub_total_ha*) are not significant.

Further, the results indicate that the relationship between subsidies and loans is non-linear. A small value of subsidies per hectare reduces bank loans (the coefficient for *sub_total_ha* is negative and significant in models 3 and 6) and as the value of subsidies increases farms use more bank loans (the coefficient for the squared value of subsidies *sub_total_ha_sq* is positive and significant in models 3 and 6). Again this holds only for total loans and for long-term loans. The short-term loans are not affected by subsidies also when the non-linear relationship is considered (model 9).

These results indicate that the hypothesis 3 holds for the total and the long-term loans whereby subsidies increase farm collateral and thus farm loan use. Multi-annuality character of the long-term investments allows the use subsidies by credit constraint farms to finance investments only through loans. For the short-term loans the estimated results suggest the validity of the hypothesis 2a. However, this does not imply that farms are not credit constraint with respect to short-term loans. Farms may still be credit

¹³ We estimate fixed effects models with heteroscedasticity-consistent standard errors.

constrained and may use subsidies to finance short-term inputs because either receiving them at the beginning of the growing season or because they may use other informal sources which may be subsidy collateralised. On the other hand, the difference in the statistical significance between the long-term and the short-term loans may indicate that farms may prefer to use subsidies to finance the long-term investments and not the short-term ones possibly because of stronger credit constraint present in the former type of investment than in the latter one.

In Table 2 we disaggregate subsidies in coupled (*sub_coupled_ha*) and decoupled (*sub_decoupled_ha*) payments and again estimate their impact on total loans (columns 1-3), long-term loans (columns 4-6) and short-term loans (columns 7-9). The results indicate important differences the two types of payments have on the farm loans. For the long-term loans (models 4-6) the effects are similar to those shown in Table 1 where long-term loans (models 4-6) were regressed over aggregated subsidies. Both coupled and decoupled subsidies have an indirect (by stimulating farm more loans of big farms than of small ones) and non-linear impact on long-term loans.

For the short-term loans, the effects of disaggregated subsidies (Table 2) differ with respect to the results reported in Table 1. The short-term loans are affected only by decoupled payments. However, the direct effect (the coefficient for *sub_decoupled_ha* in model 9) is positive and significant, whereas the interaction term (the coefficient for *sub_decoupled_fsize* in model 9) is negative and significant. These results suggest that the short-term loans are used as collateral to increase farm loans but this is more important for small farms than for big farms. The coupled payments do not affect the short-term loans: i.e. the coefficients for variable *sub_coupled_ha*, *sub_coupled_ha_sq* and *sub_coupled_fsize* are statistically not significant in model 9.

The results in Table 2 confirm that the hypothesis 3 tend to hold for the long-term loans for both types of CAP payments. For the short-term loans only the decoupled payments imply the validity of the hypothesis 3, whereas the estimated effects for the coupled payments suggest that the hypothesis 2a may better represent the reality.

The GMM estimates are shown in Table 3. Generally, the GMM results indicate different results as compared to the ones reported for the fixed effect model. When controlling for the endogeneity, the importance of subsidies in determining both the long-term and the short-term loans reduces significantly. Only the decoupled payments affect loans and the relationship is non-linear. A small value of subsidies does not affect the loans (the coefficients for *sub_decoupled_ha* and *sub_coupled_ha* are not significant in models 2, 3 and 4, 6) and as the value of subsidies increases farms use more bank loans (the coefficient for the squared value of subsidies *sub_coupled_ha_sq* is positive and significant in models 3 and 6). This holds for both types of loans.

Conclusions

In this paper we estimate the impact the CAP subsidies on farm bank loans. First, we theoretically analyse the farmers' farm loan demand under perfect and imperfect credit market assumptions. In empirical analysis we use the FADN farm level panel data to test the theoretical predictions.

According to the theoretical results, subsidies may increase bank loans, reduce them or have no impact on bank loans depending on whether farms are credit constrained, whether subsidies are allocated at the beginning or at the end of the growing season, and on the relative cost of internal and external financing.

We employ the fixed effects and GMM models to estimate the impact of subsidies on farm loans. The estimated results suggest the following impact of subsidies on farm loan use: (i) Subsidies influence farm loans and the effects tend to be non-linear and indirect. (ii) Coupled subsidies affect short and long term loans differently than decoupled subsidies. (iii) Both coupled and decoupled subsidies stimulate long-term farm loans. But long-term loans of big farms increase more than those of small farms due to decoupled subsidies. (iv) Short-term loans are affected only by decoupled subsidies. However, decoupled subsidies increase short-term loans of small farms more than those of large farms. (v) When controlling for the endogeneity, the importance of subsidies in determining both the long-term and the short-term loans reduces significantly. Only the decoupled payments affect loans and the relationship is non-linear. (vi) In general our empirical results indicate that the hypothesis 3 holds for the decoupled payments, whereas coupled payments are found not to affect loans.

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Figure 1. Farm fertilizers use with and without credit constraint

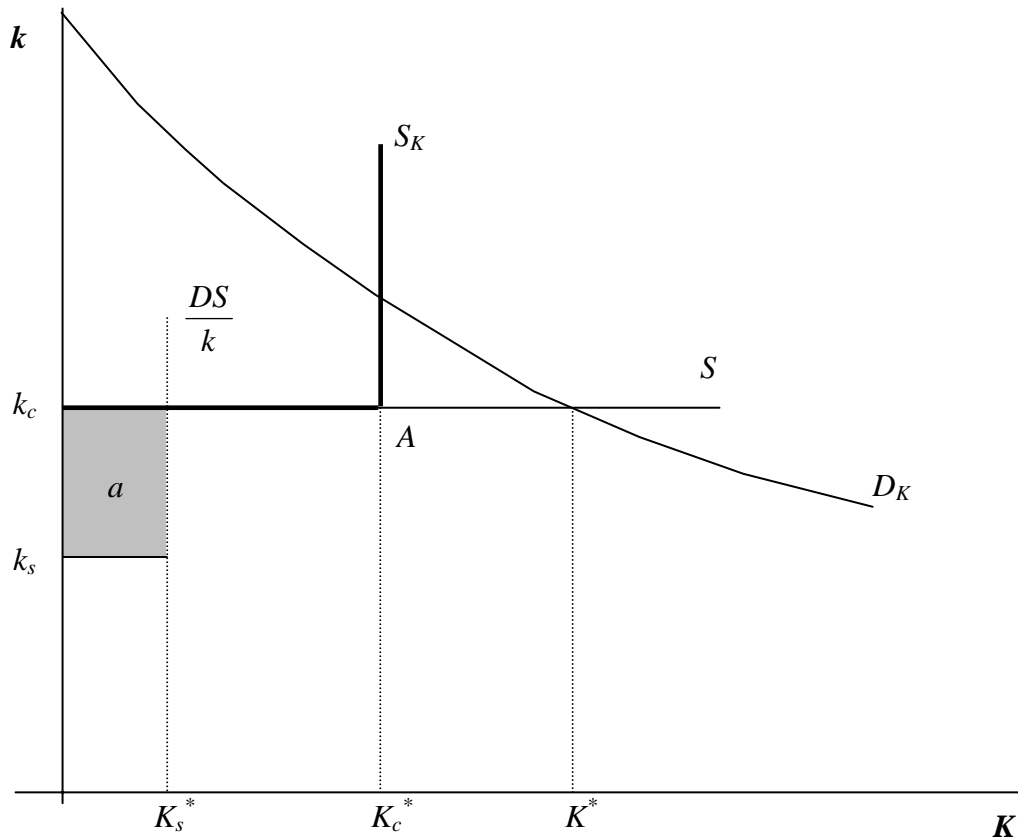


Table 1. Fixed effects estimates of loans (total subsidies)

	<i>Total loans</i>			<i>Long-term loans</i>			<i>Short-term loans</i>		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
sub_total_ha	0.0656	-0.995**	-1.075***	0.0762	-1.943***	-1.662***	0.00813	-0.142	-0.142
sub_total_ha_sq			0.000143**			0.000164**			-7.02e-07
sub_total_fsize		0.142*	0.0967		0.255**	0.158**		0.0204	0.0206
assets_ha	0.418***	0.418***	0.419***	0.406***	0.406***	0.407***	0.0522***	0.0521***	0.0521***
income_net_ha	0.246	0.246	0.247	0.301	0.302	0.303	-0.0726*	-0.0726*	-0.0726*
income_net_ha_l	-0.136	-0.136	-0.135	-0.149	-0.148	-0.147	0.000462	0.000466	0.000463
Constant	-54,495**	-54,088**	-55,396**	-44,250**	-43,310**	-45,192**	15,011***	15,091***	15,098***
Observations	237372	237372	237372	195496	195496	195496	206108	206108	206108
R-squared	0.489	0.489	0.490	0.484	0.484	0.485	0.106	0.106	0.106
Number of idn	60904	60904	60904	51360	51360	51360	54382	54382	54382

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; The estimated coefficients for the control variables X_{it} are not reported but are included in the regression..

Table 2. Fixed effects estimates of loans (disaggregated subsidies)

	<i>Total loans</i>			<i>Long-term loans</i>			<i>Short-term loans</i>		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
sub_decoupled_ha	-0.0325	-2.712***	-2.182**	0.131	-6.451***	-5.383***	-0.164***	1.120***	1.183***
sub_decoupled_ha_sq			-0.000383			-0.000878*			-8.10e-05
sub_decoupled_fsize		0.339**	0.260		0.801***	0.676***		-0.153***	-0.155***
sub_coupled_ha	0.0696	-0.945**	-1.046***	0.0740	-1.731**	-1.450***	0.0139	-0.196	-0.198
sub_coupled_ha_sq			0.000142**			0.000162**			-2.63e-06
sub_coupled_fsize		0.136*	0.0960		0.229**	0.136**		0.0282	0.0297
assets_ha	0.418***	0.418***	0.419***	0.406***	0.406***	0.407***	0.0521***	0.0522***	0.0522***
Observations	237372	237372	237372	195496	195496	195496	206108	206108	206108
R-squared	0.489	0.489	0.490	0.484	0.484	0.485	0.106	0.107	0.107
Number of idn	60904	60904	60904	51360	51360	51360	54382	54382	54382

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; The estimated coefficients for the control variables X_{it} are not reported but are included in the regression.

Table 3. Arellano and Bond estimates of loans (disaggregated subsidies)

	<i>Long-term loans</i>			<i>Short-term loans</i>		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
sub_decoupled_ha	2.434***	-4.792	0.294	0.328	-0.677	-0.415
sub_coupled_ha	2.471***	-1.644	-0.214	0.279	-0.101	-0.189
sub_decoupled_fsize		0.861**			0.118	
sub_coupled_fsize		0.482			0.0449	
sub_decoupled_ha_sq			-0.000630			0.000792
sub_coupled_ha_sq			0.000317***			0.000185***
assets_ha	0.214***	0.216***	0.215***	0.0427***	0.0396***	0.0429***
income_net_ha	0.468***	0.477***	0.431***	0.0628**	0.0511*	0.0489*
investment_ha	0.766***	0.756***	0.747***	-0.0786	-0.0593	-0.0579
L.investment_ha	0.243***	0.242***	0.260***	0.0797***	0.0886***	0.0782***
Constant	-1,948***	-172.0	-907.7***	-94.81	142.6	72.89
Observations	92328	92328	92328	95448	95448	95448
Number of idn	26792	26792	26792	28380	28380	28380

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; The estimated coefficients for the control variables X_{it} are not reported but are included in the regression.